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Juan Carlos Valdivieso[a], Paul F.J. Eagles[b] & Joan Carles Gil[a]

[a] Department of Management, Universitat Politècnica de Catalunya, Barcelona, Spain

[b] Department of Recreation and Leisure Studies, University of Waterloo, Waterloo, Canada

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Efficient management capacity evaluation of tourism in protected areas

Juan Carlos Valdivieso[a]*, Paul F.J. Eagles[b] and Joan Carles Gil[a]

[a]*Department of Management, Universitat Politècnica de Catalunya, Barcelona, Spain;*
[b]*Department of Recreation and Leisure Studies, University of Waterloo, Waterloo, Canada*

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Despite the increasing number of protected areas around the world and their importance in the conservation of species and ecosystems, protected areas management capacity remains difficult to evaluate. A standard is needed to help policy makers compare the goals with the results obtained. This empirical research builds a tool to analyze the management efficiency and predicts the new touristic outcomes in case of a policy change. Using as example the state parks agencies in the USA, this paper develops a technological frontier using data envelopment analysis based on the Protected Areas Management Approach. After that, a prediction of the outcomes is analyzed with a budget change for any state park agency. Data suggest that many of them need to improve their performance to be more efficient. Another result obtained shows how budget changes will affect each agency's performance in different degrees and, therefore, budget reductions should be modeled separately.

Keywords: protected areas; efficient management; data envelopment analysis; tourism

1. Introduction

> "A protected area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008, 9).

Dudley's definition explains the importance of protected areas (PAs) for the "conservation of nature". The World Database on Protected Areas (WDPA) catalogs 130,709 areas covering 24.23 million km^2, 27,188 of which are international (World Heritage Sites, Man and the Biosphere Programme and Ramsar Convention) PAs (WDPA 2012). The number of PAs has increased significantly in the last few years. For example, in 2011 there were 130,709 national PAs around the world. Those areas have different restrictions and can be classified in different categories, but they all play a similar role: to protect the natural resources available and to provide sites for environmental education and nature-based tourism. They now cover 12.7% of the terrestrial surface (Bertzky *et al.* 2012).

The main reason for a government to decide to protect a biozone is because of the ecological (defense and protection of nature and the environment) and the biological importance of the zone. They are trying to protect an area that is important regionally, nationally, or globally. Those natural assets attract tourism (Whitelaw, King, and Tolkach 2014).

*Corresponding author. Email: juancavaldivieso@parksmanagement.org

Although the objective proposed by the World Commission on Environment and Development in 1987 of having 12% of the terrestrial land as PA has been attained, there are many problems sustaining these important areas. These problems will increase given the new expanded objective set by the Convention on Biological Diversity in the Aichi Biodiversity Targets CBD 2010. Target 11 indicates that, by 2020, at least 17% of the land area and 10% of marine areas should be protected, this requires much higher levels of management capacity than currently exist.

Even with the importance of these areas for the conservation of the environment, many governmental agencies and NGOs are finding it very difficult to finance them with public funds (Saayman and Saayman 2006; Adams *et al.* 2008; Whitelaw, King, and Tolkach 2014). Many PAs have become "paper parks" (Dharmaratne, Yee Sang, and Walling 2000) or "half-empty" forests (Redford and Feinsinger 2001). Some parks were never opened for public use, while others have been closed (Eagles 1995). Many alternatives to a tax-based approach are being considered with tourism fees and charges as a major alternative. Some PAs are very attractive for tourists and tourism fees are the main source of income for some countries, such as those of eastern and southern Africa.

The literature reveals the links between environmental conservation in parks and tourism in those parks. Many have shown the negative impact that poorly managed tourism can have on the environment (Green, Hunter, and Moore 1990; Hardy and Beeton 2001; Huybers and Bennett 2003). There is a paradox confronting tourism and environmental conservation in PAs (Williams and Ponsford 2009; Wearing and Neil 2009). Poorly managed tourism can have a negative impact on the environment, but at the same time, a good environmental resource gives a significant attraction to the area. This explains the importance of a well-preserved area in competition with other touristic zones. Although the relationship between tourism and a PA is complex; tourism is almost always a critical component that must be taken into account in the establishment and management of PAs (Eagles, McCool, and Haynes 2002).

Tourism in PAs can generate both positive and negative impact (McCool 2006). Figure 1 shows the interaction of stakeholders in PAs. It is important to emphasize the connection between tourism and environment. Indiscriminate and uncontrolled tourism can cause damage that may be irreversible, especially in areas that are ecologically fragile. Conversely, well-managed tourism creates a conservation constituency in society and has major positive economic impacts in rural areas. Tourism has also an influence in land preserved for nature, especially in terms of quantity (Van der Duim and Caalders 2002).

The idea of a use-restricted PAs will, most likely, not provide long term protection of biodiversity becoming a "protection paradigm" (Wilshusen *et al.* 2002). The challenge is to manage the touristic use, which generates revenue and employment, while minimizing the negative impact of tourism on the environment and conserving the local ecosystems (Blanke and Chiesa 2008), taking into account that the two main objectives of PAs are: (i) the conservation and management of the natural resources and (ii) offering educational and leisure services to the visiting public (Eagles and McCool 2002). This is especially important in countries where tourism is a significant factor for development and strengthening rural economies.

Managing PAs is profoundly difficult given the multiple and, at times, ambiguous mandates (Naughton-Treves, Holland, and Brandon 2005). The key questions are whether the responsible authorities have the capacity to manage their PAs effectively and whether this management is being delivered on the ground (Hockings *et al.* 2006). Despite some improvements in the protection of important areas, global biodiversity is decreasing significantly (Butchart *et al.* 2010) showing the importance that not only is it

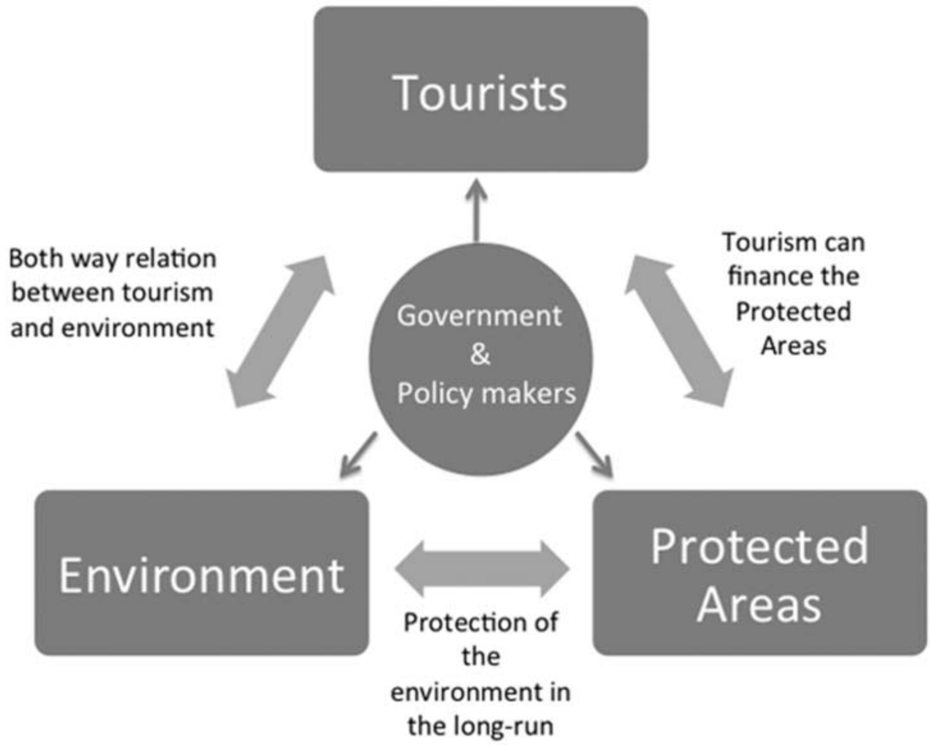

Figure 1. Interaction between the different stakeholders in protected areas.

crucial to increase the number of PAs around the world, but also having an effective and efficient management capacity to attain site objectives. A sustainability standard has not been developed (Kates *et al.* 2001) and one is difficult to identify (Moore and Polley 2007). At the same time, it is important to create a standard model that could estimate the adequate resources needed for PAs to have good management (Hockings *et al.* 2006). A standard that could tell a manager how well his work would fulfill the touristic goals in PA is desirable.

Managerial effectiveness and efficiencies are best understood through comparisons with others. How can governments know the amount of money a park needs to properly implement its goals? How can policy makers make decisions, if they do not know if a PA agency is doing well or how it can improve? (Hockings *et al.* 2006) A core question of sustainability science is how can today's relatively independent activities of research planning, monitoring, assessment, and decision support be better integrated into systems for adaptive management and societal learning (Kates *et al.* 2001).

This study aims to develop a tool to facilitate and provide adequate information to PAs managers. To attain this goal, a use of this tool allows for a comparison of results between similar agencies to help set new objectives. This approach intends to create a standard economic model of efficient touristic management for PAs. The idea is to know the inputs needed to achieve a long-term preservation of nature and the appropriate levels of human recreational use.

In their simplest form, standards can be used for application to the management of virtually all PAs, but they are necessarily general and relatively insensitive to the particular needs of individual cases (Hockings *et al.* 2006). This simple definition shows one of the main challenges of this paper: the creation of a standard that can be easily implemented and understood by PA managers, as well as other stakeholders. To date, no comprehensive methodology and theoretical framework have been proposed to evaluate the outputs of PAs (Whitelaw, King, and Tolkach 2014).

Analyzing the state park agencies of the USA and identifying the most efficient ones in touristic management will show how each state agency can improve its efficiency in a ratio input/output and, in particular, the effect that a budget change will have in the touristic outputs obtained. The objectives and scope of work presented herein require a global view. This study will use the non-stochastic and non-parametric linear programming approach of Data Envelopment Analysis (DEA) (Charnes, Cooper, and Rhodes 1978).

In the United States of America, there are two major groups of PAs: (1) the national areas that are managed by federal agencies (National Park Service, US Forest Service) and, (2) the state areas. With 8252 areas covering 14,967,686 acres (NASPD 2013), the state PAs are the biggest provider of recreational opportunities in the USA even though the national parks are better known (Landrum 2005). The State Park Agencies are in charge of the protection and management of the state PAs and each has its own policies. These agencies are funded mainly by four sources: park generated revenues, general funds, dedicated funds, federal funds and others. The park generated revenues are the main source of funding for the majority of the state park agencies, corresponding to 42% of the total revenues (NASPD 2013). The state park agencies are having difficulties in getting resources to manage the PAs, since they must compete with other higher priorities such as education, health care, public pensions, and public safety (Gilroy, Kenny, and Morris 2013).

The structure of this paper is as follows. After the introduction, the second section will provide a theoretical review of the literature about effective management in PAs, starting with an analysis of the use of efficiency approaches in the touristic industry followed by an analysis of management in PAs. The third section is the empirical analysis of the paper. It will start with an explanation of the database used and its importance. After that, the methodology used in this research will be discussed in two phases. In the first phase the DEA approach will compare every state agency to all others. The second phase will predict the new outputs in the case of a budget change. The fourth section will explain the results found in this empirical work. And, to finish, the conclusions, limitations and extensions of this work will be outlined.

2. Theoretical analysis

This research has two basic areas of investigation. The first area is the literature review of the economic efficiency in the tourism industry, and the second is an overview of the literature related to PAs management.

2.1. Efficiency approach

The economic efficiency approach has been used in product related industries basing its analysis either on parametric or non-parametric frontier models. Neither approach is preferable (Murillo-Zamorano 2004). It is a very common approach because it compares the inputs and outputs of different decisions making units with a technological frontier built with a database.

The efficiency approach has also been largely used in the tourism industry, especially in the private sector. The usual use of this approach in the tourism sector is in the hotel industry. Some of the research uses the stochastic frontier approach (Anderson *et al.* 1999; Chen 2007) while others use the DEA approach (Tsaur 2001; Brown and Ragsdale 2002; Hwang and Chang 2003; Barros 2005; Hsieh and Lin 2010).

Other papers that use the efficiency approach in the touristic sector focus on restaurants (Reynolds and Biel 2007; Sanjeev 2007) or travel agencies (Barros and Matias 2006; Köksal and Aksu 2007). In the tourism industry, another popular use of efficiency is with airlines (Barla and Perelman 1989; Coelli, Perelman, and Romano 1999; Good, Roller, and Sickles 1995; Fethi, Jackson, and Weyman-Jones 2000; Semenick and Sickles 2000; Adler and Golany 2001; Scheraga 2004; Barbot, Costa, and Sochirca 2008).

It is very hard to find researchers that use this approach in PAs and forestry because of the difficulty of collecting the required input data. Among the few papers related with this topic are Hof *et al.* (2004), Bosetti and Locatelli (2006) and Beech *et al.* (2008). The first paper uses DEA to identify areas in the USA where there is maximum potential for improving forest and rangeland condition. The second paper uses DEA to evaluate efficiency in Natural Parks in Italy. The last paper uses a stochastic approach in marine PAs in the Caribbean Sea.

A new tendency of studies in the tourism industry is the so-called eco-efficiency, where a comparison between economic welfare and environmental damage are analyzed (Gössling *et al.* 2005; Kuosmanen and Kortelainen 2005).

2.2. Protected areas management

The number of PAs around the world is increasing and it is important to improve their efficiency and effectiveness. More PAs does not necessarily mean a better environmental protection; many are not adequately managed or exist only in theory (Cifuentes, Izurieta, and de Faria 2000).

Parks play an important role in the conservation of ecosystems and species around the world. For example, in scenarios with a moderate climate change, PAs can still be an important conservation strategy (Hannah *et al.* 2007), or that the majority of tropical parks are successful at stopping land clearing and, to a lesser degree, effective at mitigating logging, hunting, fire and grazing (Bruner *et al.* 2001). Good governance and good management are important for long-term conservation and understanding of PAs (Smith *et al.* 2003; Eagles 2009).

It is essential that PAs agencies have effective management so that they can attain the stated objectives, especially in preserving the environment for future needs. PAs can only be preserved and understood by present generations, if the uses are sustainable and contribute to sustainable development, through good governance and good management (Romagosa, Eagles, and Duitschaever 2012). Management in PA is "the combination of actions with a legal, political, administrative, research, planning, protective, coordinating, interpretative or educational character, that results in the better use and permanence of a protected area, and the accomplishment of its objectives" (Cifuentes, Izurieta, and de Faria 2000). Understanding the management effectiveness of PAs has emerged as a dynamic subfield of PAs management (Hockings 2003).

One of the approaches that analyze the management in parks is protected area management effectiveness (PAME). PAME is the "assessment of how well the protected area is being managed, primarily the extent to which it is protecting values and achieving goals and objectives" (Hockings *et al.* 2006, xiii). This framework was developed for the

Table 1. Inputs/outputs (Hockings et al. 2006).

Inputs	Outputs
• Staff	• Number of users
• Funds	• Measures of the volume of work output
• Infrastructure and equipment	• Measures of physical outputs
• Access to information	

International Union for Conservation of Nature (IUCN) and the World Commission on Protected Areas IUCN−WCPA. The effectiveness in PAs can be considered at four different, complementary levels: coverage, broad scale outcomes, PA management effectiveness assessments and detailed monitoring (Leverington *et al.* 2010).

The use of PAME as a measure of the effectiveness studies is expanding and now many agencies use it or demand the use of it, especially after the Convention of Biological Diversity's Programme of Work on Protected Areas has set the goal of evaluating and improving the effectiveness of PAs management across the world (Belokurov *et al.* 2009). A study developed by Leverington *et al.* (2010) shows that more than 8000 evaluations of effectiveness of PA management have been conducted, revealing the widespread utility of this concept.

It is crucial to develop a "clear and unbiased picture of the inputs available and to identify gaps and shortfalls (or waste and over-spend if this is occurring)" in PAs management (Hockings *et al.* 2006) and this is precisely what this study is trying to determine.

2.2.1. PAME: inputs/outputs

The study of efficiency in PAs has a special challenge. The efficiency approach has been largely used in industries with physical products because it is easier to quantify the inputs needed to develop such a product. On the other hand, PAs have a much more complex approach because it is difficult to define and quantify the inputs and outputs of the services, such as ecological and tourism services.

The following methodology is based on the PA management approach (Hockings *et al.* 2006). The framework that evaluates management effectiveness is a reference in the sector. The inputs and outputs of PAs management, as described in that study, are shown in Table 1.

This evaluation method is regarded as having greater "explanatory power" because it permits examination of the possible links between performances in different parts of the management cycle. For example, what is the influence of budget or staff numbers on the outputs (Hockings *et al.* 2006). Outputs are the products and services delivered by management action. The outcomes are the result of the outputs. It is important to distinguish outputs from outcomes (Hockings 2003; Leverington and Hockings 2004). The approach we are using focuses only on the relation between inputs and outputs in parks agencies.

3. Empirical analysis

3.1. Data

To evaluate the effectiveness of PAs is difficult, especially given the poor availability of data on ecological and social conditions and their change over time (Naughton-Treves, Holland, and Brandon 2005); this happens even in countries with a high number of tourists in national parks like Spain (Muñoz-Santos and Benayas 2012).

One exception is the extensive data set found in the National Association of State Park Directors (NASPD) Annual Information Exchange Report. This report is developed yearly and has important information about PAs state agencies in the United States of America. This important dataset and the associated report are developed every year by the NASPD. All data are provided by the 50 state park agencies for their respective states. For this study we are using the information for the period between 1 July 2011 and 30 June 2012.

Given the focus of this study and the dataset available, this research uses as inputs the budget, the number of staff members, and the total number of campsites. The outputs are the total number of visitors and the total revenue generated. To date, the most widely used tourism related approach to funding PAs has involved the levying of fees directly on visitors or through licensing commercial operators and the provision of concessions and leases (Whitelaw, King, and Tolkach 2014). In this case, due to the debate in the literature related to the optimal number of tourists in PAs, the variable of total number of visitors has been treated as a fixed output. This means that the analysis will be run assuming that the number of visitors cannot be changed. Historically, the parks receive whatever visitor use occurs, and then try to develop mechanisms to define and manage appropriate activities and levels of use (Eagles 2002). The relationship between visitor numbers and the marketability or attractiveness of the area will shape the style of the services offered and the prices that are charged (Whitelaw, King, and Tolkach 2014).

3.2. Methodology

The model builds an economic standard for tourism in PAs management capacity that evaluates the impact that a change in the inputs will have in the new outputs. In the literature, there is a need for such a model for an evaluation of efficiency and effectiveness in PAs. This research aims to fill this gap by developing and testing an economic standard that can be replicated in different regions and countries.

This research was developed in two phases. The first phase is a comparison of the different decision making units (DMU) using a non-parametric approach that compares them with a technological frontier. Based on the PAME approach, three available inputs will be used: total operating expenses, total staff, and total number of campsites available. These resources will be contrasted with two outputs: the total number of visitors and total revenue generated. The first phase will analyze the most efficient DMUs by comparing them with the technological frontier created. This study allows analysis of whether management is getting the maximum results with the resources available. The second phase is the development of a tool, based on the technological frontier developed in the previous phase, to predict future results if one or more inputs change in a specific state park agency. This prediction will be done running a simulation with the new resources.

3.2.1. Phase 1

DEA is a non-stochastic and non-parametric linear programming approach that calculates efficiency in relation to a production frontier established by the industry (Coelli *et al.*

2005). In other words, it measures the performance of each unit in relation to the performance of the other units with the same goals and objectives.

DEA was first introduced by Charnes, Cooper, and Rhodes (1978) based on the quantity index constructed by Malmquist (1953) and an extension of the Farrell's estimation of technical efficiency with respect to the production frontier (Farrell 1957). Charnes, Cooper and Rhodes proposed that "the measure of the efficiency of any DMU is obtained as the maximum of a ratio of weighted outputs to weighted inputs subject to the condition that the similar ratios for every DMU be less than or equal to unity" (1978, 430). The idea is to maximize the outputs obtained using a certain amount of inputs. This will calculate the efficiency of a DMU with respect to a production frontier. It is a very common approach because no assumption is done and prices or cost data are not involved.

In this case, the DMUs will be the state park agencies and n is the number that will be evaluated. Every DMU will use m inputs to produce s outputs. Let X_j be the input consumption vector for DMU_j where $X_j = (x1_j; \ldots; xm_j)T$, and Yj the output production vector, $Yj = (y1_j; \ldots; ys_j)T$.

This model is output-oriented because the objectives of the parks are not standardized. This means that not all state park agencies or parks have the same objectives. Therefore, this method will look for the maximum outputs possible using the inputs available in the present. The idea can be simplified as: if two parks agencies have the same inputs, the one with more outputs is more efficient than the other one. In other words, this approach defines efficiency as the maximum possible output (i.e. total revenue generated) that could be obtained with the current inputs given the present technological frontier.

The DEA output efficiency score under a constant return of scale (CRS) assumption for DMU′, θ', is given by:

$$\theta' = \max_{\lambda\theta} \theta$$

$$\text{s.t.}$$

$$X' \geq \sum_{j=1}^{n} \lambda_j X_j$$

$$\theta \mathrm{Y}' \leq \sum_{j=1}^{n} \lambda_j Y_j$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

The DEA has some advantages that in this case are very important. For example, no prices or costs are needed. The other important advantage is that it does not require an assumption of the functional form relating inputs and outputs and they can have different units.

The distance between the current outputs and the production frontier is called distance function. Shephard introduced the distance function (Shephard 1953; Shephard, Gale, and Kuhn 1970); this is a measure that evaluates a single DMU compared with the production frontier using a vector of inputs and a vector of outputs. The distance function measures the distance between the observed unit and the maximum production that could be attained; in other words, how inefficient it is.

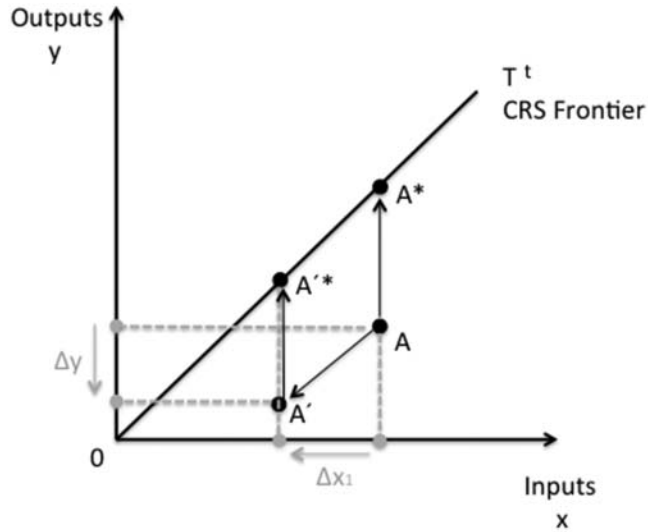

Figure 2. Simulation of the interaction between a change in the budget ($\Delta x1$) and the change in the outputs (Δy).

3.2.2. Phase 2

The second phase is based on the results obtained in the previous phase. Once managers are aware of the level of outputs they should obtain to be efficient, then the search focuses on the possible outcomes that will be obtained if the state park inputs are changed. This paper focuses on the prediction of outputs in the case of a total operating expense change, but this could be replicated for any input. Figure 2 shows the idea of this section. If we take point A as the vector of inputs and outputs of a DMU, $A*$ will be the efficient point. If there is a change in an input, in this case a change in the budget ($\Delta x1$), A' will be the predicted output that will be obtained by this DMU.

This new model uses the results obtained in the previous phase by imposing a CRS. The CRS approach assumes a constant ratio between inputs and outputs while the approach of variable return of scale (VRS) interprets the proportion may be increasing, constant or decreasing. Graphically, it is possible to see the difference between CRS and VRS in Figure 3.

The summary of the two phases is shown in Figure 4. The first objective of a state parks agency is to become efficient compared with the other agencies. Once it is efficient, it is possible to predict the new outputs that will be obtained if the inputs change.

4. Results

4.1. Results phase 1

After building the technological frontier using DEA based on the Protected Areas Management Approach, eight state agencies are revealed as being efficient: Hawaii, Kentucky, Nebraska, New Hampshire, Oklahoma, South Dakota, Washington and Wisconsin. As shown in Table 2, these eight state agencies have a distance function equal to one using the CRS model, meaning that they are located at the technological frontier. There are also four agencies that are very close to being efficient: South Carolina,

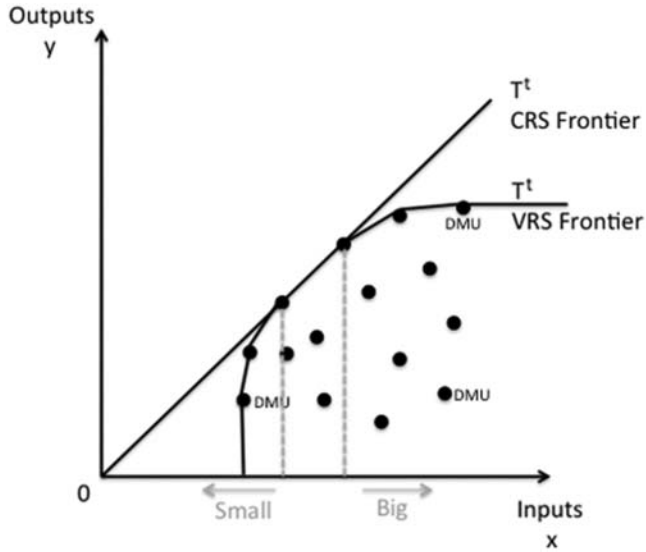

Figure 3. Simulation of the size of the agencies and comparison between constant return of scale (CRS) and variable return of scale (VRS) frontiers.

Florida, Arizona and Alabama. These agencies just need to improve their outputs less than 5%.

The results also show that some state parks agencies have large problems of inefficiency. One can see that, if they want to be efficient, some parks agencies should increase their outputs more than three times with the present inputs (Alaska, Montana, Massachusetts, Illinois, North Carolina and Wyoming). For example, the State of

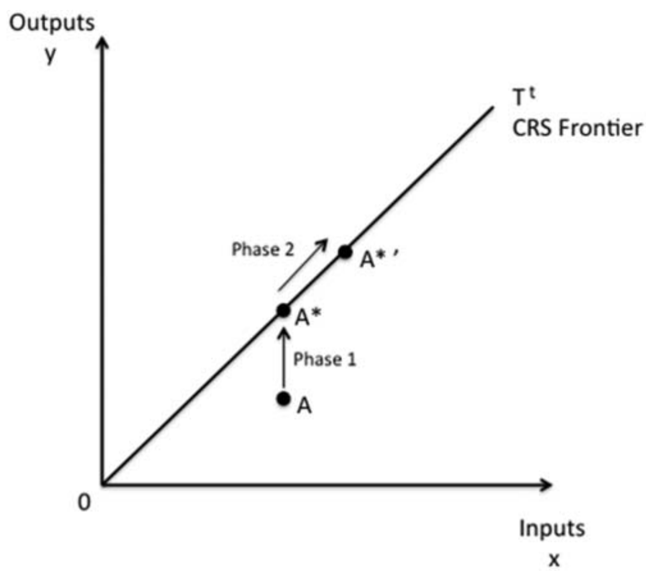

Figure 4. Illustration of the two phases of this study. Phase 1 is the allocation of the PAs in the efficient production frontier and phase 2 is the change of objectives that are the target.

Table 2. Distance function of technical efficiency and size of state park agencies.

	Phase 1				Phase 1		
State	CRS $Fo(x1, x2, x3, y1^{*}, y3)$	VRS $Fo(x1, x2, x3, y1^{*}, y3)$	Size	State	CRS $Fo(x1, x2, x3, y1^{*}, y3)$	VRS $Fo(x1, x2, x3, y1^{*}, y3)$	Size
Alabama	1.05	1.03	Big	Montana	3.66	2.60	Small
Alaska	3.45	2.33	Small	Nebraska	1.00	1.00	Efficient
Arizona	1.04	1.00	Small	Nevada	2.24	1.72	Small
Arkansas	1.20	1.00	Big	New Hampshire	1.00	1.00	Efficient
California	2.19	1.00	Big	New Jersey	2.39	1.63	Big
Colorado	1.73	1.69	Big	New Mexico	2.66	2.46	Small
Connecticut	2.43	2.40	Big	New York	2.12	1.00	Big
Delaware	1.38	1.33	Big	North Carolina	4.74	3.92	Big
Florida	1.02	1.00	Big	North Dakota	2.35	1.00	Small
Georgia	1.11	1.10	Big	Ohio	1.69	1.00	Big
Hawaii	1.00	1.00	Efficient	Oklahoma	1.00	1.00	Efficient
Idaho	1.90	1.83	Small	Oregon	1.70	1.00	Big
Illinois	3.95	1.00	Big	Pennsylvania	2.72	1.80	Big
Indiana	1.15	1.00	Big	Rhode Island	1.41	1.22	Small
Iowa	2.10	1.70	Big	South Carolina	1.01	1.01	Big
Kansas	1.72	1.49	Small	South Dakota	1.00	1.00	Efficient
Kentucky	1.00	1.00	Efficient	Tennessee	1.44	1.00	Big
Louisiana	2.17	2.11	Small	Texas	1.42	1.24	Big
Maine	2.12	1.48	Small	Utah	1.24	1.22	Small
Maryland	1.70	1.63	Big	Vermont	1.86	1.73	Small
Massachusetts	3.69	2.45	Big	Virginia	1.64	1.52	Big
Michigan	1.12	1.00	Big	Washington	1.00	1.00	Efficient
Minnesota	2.98	2.85	Big	West Virginia	1.35	1.23	Big
Mississippi	1.39	1.21	Small	Wisconsin	1.00	1.00	Efficient
Missouri	2.13	1.69	Big	Wyoming	5.31	3.94	Small

Notes: Fo(x,y): Farrell output-oriented measure of technical efficiency
$y1^{*}$: fixed visitor variable
Shaded rows: efficient state park agencies.

Massachusetts could multiply its revenues by 3.69 times with the present technological frontier. This means that, compared with the other state parks agencies, the State of Massachusetts could be able to increase its revenues by 369%. In this research, the greater the distance function, the higher the inefficiency.

Another visible result in this study is the scale problems and the size of the state park agencies. In Table 2, we can see that some park agencies are efficient in the VRS model and not in the CRS model. One of the reasons for this difference is due to the scale problems. In Figure 3, it is possible to observe graphically how the DMUs that are located at the left of the efficient ones are too small and the ones at the right are too big. For example, California has an inefficiency of 2.19 in the CRS, but it is efficient in the VRS. This means that this DMU should decrease in size, i.e. it is too big compared to the other state parks agencies. The same happens, in a smaller level, with New York State Agency. On the other hand, Arizona and North Dakota State Park Agencies are too small and should increase their size. The average productivity at the most productive scale size may not be attainable for other scale sizes (Banker, Charnes, and Cooper 1984). This refers only to the management input and not to the size of the PAs. It is interesting to see that, besides the efficient agencies, the other state agencies' management capacities are either too small or too big. The explanation of this behavior could be that the eight efficient state agencies are very close to each other and they have the ideal size, at least for this model.

4.2. Results phase 2

The results from phase 2 of this empirical research reveal that each state park agency will have a different reaction in case of a change in the inputs. This model uses as example a 5% increase and a 5% decrease in the budget. This percentage followed the 5% sequestration budget cuts mandated by the Congress of the United States of America in March 2013 for federal agencies. This was a federal government reduction, but the figure gives a possible change that could occur in state parks.

As expected, a budget change will not affect the outputs of all agencies in the same extent. Some state park agencies will not be affected with this change and others will be widely affected. In Table 3, it is possible to see that this budget change will lead to a change between 0% and 10.2% of the total revenue. The reason is due to the weight that budget has in the outcomes of each state park agency. If we take as an example the State of Texas, we can see that an increase of 5% in the budget will result in an increase of 2.61% in the outputs. This means that, for example, the total predicted revenue generated would increase more than $1 million with a 5% increase in the budget, from $39,279,567 to $40,304,763. To be efficient, they have to increase the revenues to almost $57.5 million.

This phase 2 finding can be interpreted as the effect that a decision would have in the outputs. Returning to Figure 2, we see that a change in the budget would change the new point of efficiency but maintain the theoretical distance to the technological frontier. If we take the State of New York as an example, a variation of 5% in the budget would have an effect on the total revenue of 2.75%, but the distance to the technological frontier would still be 2.12.

It is surprising to see that some state parks agencies are not affected in the same proportion with the increase of 5% of the budget than with the decrease of 5%. This difference between an increase and a decrease in the budget could be due to the so-called

Table 3. Simulation of a 5% change in the budget for each state separately to see the outputs change.

	Phase 2			Phase 2	
State	Change in $y3$ with a decrease of 5% of the budget	Change in $y3$ with an increase of 5% of the budget	State	Change in $y3$ with a decrease of 5% of the budget	Change in $y3$ with an increase of 5% of the budget
Arizona	0.00%	0.00%	Louisiana	−2.94%	2.94%
New Mexico	0.00%	0.00%	Georgia	−3.09%	3.09%
Utah	−0.33%	0.06%	Massachusetts	−3.15%	3.15%
Oregon	−0.45%	0.07%	Illinois	−3.26%	0.65%
Washington	−1.17%	0.00%	Minnesota	−3.27%	0.75%
Virginia	−1.54%	1.54%	Pennsylvania	−3.40%	3.40%
Delaware	−1.63%	1.63%	Florida	−3.43%	3.43%
New Jersey	−1.81%	1.81%	Kentucky	−3.57%	0.00%
West Virginia	−1.86%	1.86%	Tennessee	−3.65%	2.41%
Arkansas	−2.05%	2.05%	North Dakota	−4.28%	4.28%
California	−2.11%	1.56%	Maine	−4.94%	4.94%
Indiana	−2.43%	2.43%	Wyoming	−4.95%	4.95%
Vermont	−2.52%	2.52%	Hawaii	−5.00%	0.00%
North Carolina	−2.56%	2.56%	New Hampshire	−5.16%	1.04%
Idaho	−2.57%	2.57%	Oklahoma	−5.40%	0.00%
Mississippi	−2.58%	2.58%	Michigan	−5.70%	5.48%
Texas	−2.61%	2.61%	Alaska	−6.04%	1.43%
Connecticut	−2.62%	2.62%	Kansas	−6.06%	6.06%
Alabama	−2.63%	2.63%	Missouri	−6.22%	2.91%
Nevada	−2.65%	2.65%	South Dakota	−6.51%	5.00%
Montana	−2.73%	2.73%	Rhode Island	−6.92%	6.92%
South Carolina	−2.74%	2.74%	Nebraska	−6.97%	6.09%
New York	−2.75%	2.75%	Ohio	−7.26%	6.85%
Maryland	−2.85%	2.85%	Wisconsin	−7.39%	6.17%
Colorado	−2.88%	2.88%	Iowa	−10.20%	10.18%

"slack". The problem with slacks continues to be deficient in DEA in its treatment to non-zero slacks (Cooper, Seiford, and Zhu 2011).

5. Conclusions, limitations and extensions

Target 11 of the Aichi Targets calls for an increase of the number of PAs, and an increase in effective and equitable management (Woodley *et al.* 2012). It is recommended that management agencies, partners and funders continue to cooperate to help PAs achieve minimum basic standards (Leverington *et al.* 2010). This empirical work shows interesting results that can be useful for stakeholders. Visitor related developments generally represent both the best opportunity for appreciation of the park and the key internal threats to its biophysical or cultural integrity (Eagles and McCool 2002).

Two main conclusions were found in this study. The first one is the importance that DEA has for comparing parks agencies and evaluating their touristic management capacity. Tourism will not only provide needed funding for management but also serve as an engine of economic development and benefits for nearby residents and communities (McCool *et al.* 2012). This methodology allows for comparison of the managers' performance of the different PA systems through evaluating the results of the revenue generated.

Managers will want to know who is affected by an action and how (Eagles and McCool 2002). The second part of the research answers this uncertainty: how they are affected by a change? It is important to know the impacts that the different actions will have on the outputs. This section shows that it is possible to predict the new outputs if there is a change in the inputs. Particularly, this analysis illustrates the effect that a 5% change in the agency's budget will have in the total revenue they will generate. This will help stakeholders to quantify changes and consequently to take better decisions. As a conclusion of this section, we can say that each state agency will be affected in a different degree and if the government decides to make a budget reduction, it should consider that each park agency would be affected in a different degree.

Finally, this paper allows state park agencies in the USA to see their performance and the problems associated with achieving the tourism efficiency. This methodology could be replicated and some extensions could be done with other groups of agencies or with individual PAs.

DEA is an effective approach in cases with no strict functional relationship between factors of production like the public sector or the non-profit organizations (Golany and Roll 1989). At the same time it has some limitations. The first challenge facing this approach, in order to be implemented, is the need to have all the values of the required variables (Sena 2003), this reduces the number of DMUs available. It also evaluates only the relative efficiency within the studied group (Golany and Roll 1989) and not with the theoretical maximum. Related to this study specifically, the research uses an extensive dataset that was created for other purposes. For that reason the approach had to be adapted. For example, for the input infrastructure and equipment, the only data available to all states were the number of campsites. This variable only exemplifies the infrastructure available. Another important limitation of this methodology is that it only compares the inputs and outputs of PAs and does not take into account the entire framework for assessing management effectiveness of PAs.

Other than the limitations of the methodology *per se*, this approach has also other ones. This study uses only quantitative variables that are easier to obtain but they are not always representative. For example, not only it is important to use the number of employees but also the level of education, the personnel incentives and the effective time dedicated to the park. For future studies, it will be important to take this limitation into account.

Several extensions can be derived from this study. This paper only analyzed the efficiency from a touristic point of view. Future studies should involve all outputs of the protected areas management effectiveness. This is especially difficult to due to the absence of data available containing the information required. In case of obtaining the information, it would also be interesting to replicate the research comparing the different governance model and study if there are differences between them. For that research, it will be important to focus on the eight most common management models: (1) Golden Era National Park model; (2) Parastatal model; (3) Non-profit Organization model; (4) Ecolodge model; (5) Public and For-profit Private Combination model; (6) Public and Non-profit Private Combination model; (7) the Aboriginal Ownership and Government Management model; and (8) Traditional-Community model (Eagles 2009).

Another interesting extension to this approach will be to add, to the model, bad outputs (Scheel 2001). Normally, when using DEA approach, the outputs analyzed are good outputs. But this is not always true because bad outputs such as CO2 emissions, deforestation or animal extinction may exist.

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